DOI: https://doi.org/10.52756/ijerr.2025.v47.015 *Int. J. Exp. Res. Rev.*, Vol. 47: 174-185 (2025)

Original Article | Peer Reviewed | Open Access

International Journal of Experimental Research and Review (IJERR)

ISSN: 2455-4855 (Online)
www.iaph.in

Environmental Degradation Channels and Economic Growth in Nigeria (1990-2023)

Jonathan Ojarikre Oniore[1] and Pureheart Ogheneogaga Irikefe[2]*

[1]Department of Economics, Faculty of Social Sciences, Bingham University, Karu, Nigeria; [2]Graduate School of Business, Asia Pacific University of Technology and Innovation, Kuala Lumpur, Malaysia

E-mail/Orcid Id:

SB, jo.oniore@binghamuni.edu.ng, https://orcid.org/0000-0002-6526-722X; *DS*, pureheart.irikefe@apu.edu.my, https://orcid.org/0000-0002-5486-1389

Article History:

Received: 05th Dec., 2024
Accepted: 08th April, 2025
Published: 30th Apr., 2025

Keywords:
CO_2 Emissions, Economic Growth, Environmental Kuznets Curve, Foreign Direct Investment, Health Expenditure per Capita, Trade Openness

How to cite this Article:
Jonathan Ojarikre Oniore and Pureheart Ogheneogaga Irikefe (2025). Environmental Degradation Channels and Economic Growth in Nigeria: 1990-2023. *International Journal of Experimental Research and Review*, *47*, 174-185.
DOI: https://doi.org/10.52756/ijerr.2025.v47.015

Abstract: Rapid global economic growth has increasingly been linked with rising environmental degradation, particularly in emerging economies, creating a need for balancing economic expansion and environmental sustainability. Nigeria, with carbon emissions reaching approximately 127.942 megatons and a declining GDP per capita of $1,621 in 2023, exemplifies this critical challenge. This study examines the impact of environmental degradation on the Nigerian economic growth between the periods 1990 and 2023 using the Fully Modified Ordinary Least Squares method to test the hypothesis of the Environmental Kuznets Curve (EKC). It specifically investigates the impact of trade openness, foreign direct investment (FDI), and per capita health expenditure channels in affecting the relationship. The results showed a marginally significant positive correlation between economic growth and carbon dioxide emissions ($\beta=0.028$, $p=0.066$). This suggests that Nigeria is still in the early stage of EKC, where economic expansion is still having a negative environmental impact. While trade openness had no effect, FDI had a significant negative impact on economic growth ($\beta=-0.174$, $p=0.003$), suggesting that current foreign investments may have negative environmental effects. Economic growth was significantly boosted by health expenditure per capita ($\beta=0.876$, $p=0.000$), highlighting the significance of this investment in reducing the negative health effects of the environment and increasing productivity. The study recommends that Nigeria's National Environmental Standards Regulatory and Enforcement Agency should intensify environmental regulations and encourage green foreign investment in the bid to abate the negative environmental effects linked with economic development. Additionally, the Federal Ministry of Health should increase per capita health spending to enhance labour productivity and reduce environmental health risks, thus facilitating a sustainable economic trajectory that mirrors the EKC turning point.

Introduction

The intricate interplay between energy production, economic growth, and environmental sustainability has garnered significant attention in contemporary research. Energy's vital importance fuels growing demand to strike a compromise between environmental sustainability and economic development (Munir et al., 2020; Abdulkarim, 2023). While energy mostly propels economic growth, it also negatively affects the environment (Kanat et al., 2022; Hammed et al., 2020). According to Ogunbode et al. (2021), many harmful environmental outcomes are a result of human actions carried out in order of survival and progress without taking cognisance of sustainability.

Global economic development has been robust, with the global GDP per capita approximating $13,138 in 2023, indicating a 3.21% rise from 2022 (Macrotrends, 2023). With GDP per capita average around $6,800 (IMF, 2023), emerging nations such China, India, and Brazil have seen notable increase. By comparison, Nigeria's GDP per capita in 2023 ($1,621) is 25.04% lower than that of 2022 (Macrotrends, 2023). With increasing environmental degradation, this is most

*Corresponding Author: pureheart.irikefe@apu.edu.my

concerning. Nigeria's carbon emissions were also estimated to be at 127.942 megatons in 2023 and is one of Africa's biggest emitters (CountryEconomy, 2023). This speaks volume about Nigeria's need to balance economic growth and environmental concern at the earliest opportunity.

Environmental degradation and global warming have recently become the concern of both policymakers and scholars. Since the 1990s, a central issue of economic research has been how economic growth is associated with environmental degradation, particularly as argued by the Environmental Kuznets Curve (EKC) hypothesis. Grossman and Krueger (1995), who propounded the EKC, assert that the early phases of economic expansion correlate with elevated pollution and environmental degradation; however, once a certain per capita income threshold is surpassed, further growth leads to environmental improvement. Therefore, economic activity and environmental degradation have an inverted U relationship (Amar, 2021).

Mixed empirical verification of the EKC has been reported. Some empirical works affirm it (Mohammed et al., 2024; Abdulkarim, 2023; Acheampong and Opoku, 2023; Hammed et al., 2020; Maneejuk et al., 2020; Beyene and Kotosz, 2019; Grossman and Krueger, 1995) while others do not affirm its assumptions (Raihan et al., 2022; Adu and Denkyirah, 2018). Moreover, other studies, such as Yan et al. (2022) and Cetin (2018), have shown conflicting results for the EKC across many countries. In Nigeria, however, the data still seems contradicting and lacking.

Informed policymaking depends on an awareness of how different pathways of environmental degradation affect economic development. This current study seeks to provide such knowledge that would enable the establishment of policies balancing environmental sustainability with economic growth. Environmental degradation can affect economic growth through openness to trade, foreign direct investment (FDI), and human health channels. Hence it is paramount to research and provide clarity as to how these interactions can guide and influence policy choices.

This current study contributes to the modern discussion on the EKC by investigating its existence and policy relevance within the Nigerian context. It does so in a comprehensive manner, examining the impact of environmental degradation on economic growth in Nigeria and identifying the potential channels through which this influence operates, namely trade openness (Abdulkarim, 2023), FDI (Opoku et al., 2022), and per capita health expenditure (Jayadevan, 2021). The current study employs cointegration techniques and Fully Modified Ordinary Least Squares (FMOLS) estimation on data from 1990-2023 to achieve this. The following research questions represent the thrust of the current study:

i) How does carbon dioxide emissions impact on economic growth?
ii) What impact does trade openness have on economic growth in Nigeria?
iii) To what extent does foreign direct investment impact Nigeria's economic growth?
iv) What is the impact of health expenditure per capita on economic growth in Nigeria?

Literature Review

Environmental Degradation

Environmental degradation means the deterioration of the natural environment over a period of time due to human actions (Aluko et al., 2021). Ogunbode et al. (2021) averred that it includes depletion of natural resources like air, water, and land, contamination of the ecosystems, degradation of wildlife habitats, and biodiversity loss. Hence, all human-generated activity that causes harm to the environment—be it social, economic or technological—can result in environmental degradation. Pona et al. (2021) cite common drivers of degradation in developing countries like Nigeria as high population growth, urbanisation, intensive agriculture, deforestation, and excessive consumption of energy. In empirical research, CO_2 emissions are commonly utilised as a proxy for environmental deterioration since CO_2 is among the prominent greenhouse gases leading to climate change (Ekonomou and Halkos, 2023). CO_2 emissions are generally expressed as the weight of CO_2 released from the combustion of fossil fuels and cement production and generally reported in terms of kilotons (kt).

Economic Growth

Economic growth is conventionally defined as an increase in the capacity of an economy to produce goods and services over time, typically measured by the growth rate of real gross domestic product (GDP) (Awosusi et al., 2022). GDP is the market value of all final goods and services produced within a country in a given period. In practice, economists focus on real GDP growth (inflation-adjusted) to compare output over time. Growth rates are usually reported as the annual percentage change in real GDP or real GDP per capita. When output of goods and services rises, the economy is said to be expanding. For cross-country comparisons and empirical analysis, GDP per capita (total GDP divided by population) is often

DOI: https://doi.org/10.52756/ijerr.2025.v47.015

used, since it captures how economic output relates to population size (Le et al., 2024). For example, many studies use GDP per capita as a proxy for economic growth to account for both total economic output and population differences (Awosusi et al., 2022). In our study, GDP per capita is chosen because it is widely used in the literature and effectively reflects national prosperity in relation to population.

Trade Openness

Trade openness generally refers to the degree to which a country allows free trade with the rest of the world. Practically, it refers to reducing trade barriers (e.g., tariffs, quotas), liberalising capital flows, and reducing import and export controls (Rehman et al., 2021). Trade openness is generally considered by policymakers as a way of promoting technological diffusion, competitiveness, and efficiency in the economy. An entirely open economy with regard to trade will possess a higher ratio of trade (sum of imports and exports) to GDP. Indeed, among the usual openness measures of trade is the ratio of trade to GDP, defined as the exports plus imports divided by GDP (Mugun, 2021). The trade-to-GDP ratio is a broad indicator of how much an economy is connected with world markets. In emerging economies like Nigeria, increased trade openness has the potential to bring about technology transfer and scale effects but also has the potential to lead to environmental pressures if dirty industries expand or poor environmental regulation attracts dirty industries (so-called pollution haven effect) (Jide et al., 2023). In this study, we use the share of trade in GDP as the openness indicator, following the literature on trade-policy measures.

Foreign Direct Investment

Foreign Direct Investment (FDI) is investment coming from abroad to establish a lasting interest in a business enterprise in the host country (Islam and Beloucif, 2023). The World Bank's standard definition characterises FDI as net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. In practical terms, FDI includes equity capital investment, reinvested earnings, and other long-term investments by foreign entities. In Nigeria, FDI often comprises the bulk of foreign private capital inflows, especially through multinational corporations engaged in oil, mining, or telecommunications (Agbana et al., 2024). While FDI brings in capital, employment and new technologies, it can also be associated with environmental degradation if foreign firms pollute without proper controls (Orji et al., 2021). To capture FDI in our empirical model, we use FDI as a percentage of GDP, which represents the amount of foreign capital inflow relative to the size of the economy.

Health Expenditure per Capita

Health expenditure per capita measures the average amount spent on health care for each person in a country. Nguyen et al. (2023) averred that it includes both public and private spending on medical services (doctor visits, hospital care, etc.), pharmaceuticals, public health programs, and related health goods and services. Expenditure on capital formation (health infrastructure) is typically excluded from this definition. Health expenditure is usually converted to a common currency (US dollars) and adjusted for purchasing power parity (PPP) so that comparisons across countries or over time are meaningful. A higher health expenditure per person generally indicates better access to medical care and health infrastructure, which tend to improve population health (Mitkova et al., 2022). In this current study, health expenditure per capita is considered a potential channel linking environment to growth—a cleaner environment can reduce health burdens (for example, fewer respiratory or waterborne diseases), which in turn can improve labour productivity and economic output. Thus, health expenditure per capita is included to capture this health–growth linkage.

Theoretical Framework: Environmental Kuznets Curve

This current study's theoretical framework is the Environmental Kuznets Curve (EKC), which links CO_2 emissions to economic growth. Grossman and Krueger (1995) investigated the relationship between economic growth and income inequality, confirming the EKC hypothesis. Grossman and Krueger (1995) concluded that early economic growth is associated with an increase in income disparity up to a point, beyond which inequality is mitigated by continued economic expansion (Saba, 2023). Early-stage growth is associated with higher emissions. However, as economies of scale, money, and innovation increase, higher productivity becomes environmentally sustainable. Consequently, a negative U-shaped relationship between environmental degradation and economic growth was established. On the basis of this finding, the EKC hypothesis has gained substantial acceptance (Maneejuk et al., 2020; Beyene and Kotosz, 2019).

Usually, pollution and economic development are directly related. There are several ways to reduce the links between these two, though, including using environmentally friendly technologies and creating technical breakthroughs that ensure general rises in economic output and, more importantly, pollution

reduction (Acheampong and Opoku, 2023; Hammed et al., 2020). Though there is cynicism about the idea of infinite substitution or technical progress, there might be limits on how far these connections can be further relaxed in the future. As employed by Stern (2004) 2003, the functional relationship can be expressed as:

$$(E/P)_t = f(GDP/P)_t \tag{1}$$

Equation (1) can be explicitly written as:

$$In(E/P)_t = \alpha + \gamma_t + \beta_1 In(GDP/P)_t + \beta_2 (In(GDP/P)^2{}_t + \varepsilon_t \tag{2}$$

Where *'ln'* stands for natural logarithms, P is the population, and E is the amount of carbon emissions. The number of years is indicated by the subscript *'t'* on the RHS, while the first two terms are intercept parameters. It is assumed that, while emissions per capita may vary throughout nations at a given income level, income elasticity is constant across nations at a given income level. However, in order to facilitate empirical modelling in this research, GDP per capita was used to represent the dependent variable, and carbon emissions (CO_2) was used to represent environmental degradation. This made it possible for the study to demonstrate how environmental degradation affects Nigeria's economic growth. Equation (2) can now be written in a functional form as:

$$GDPPC = f(CO_2) \tag{3}$$

Where GDPPC stands for gross domestic product per capita as a measure of economic growth and CO_2 stands for carbon emissions as a proxy for environmental degradation. Explicitly, equation (3.3) can be written as:

$$GDPPC = \alpha + \beta(CO_2) + \varepsilon \tag{4}$$

Empirical Review

In support of EKC hypothesis, Mohammed et al. (2024) analyse the EU (1990–2019), finding that energy use rose as CO_2 emissions fell, with an inverted-U EKC (1% GDP→+0.705% emissions, 1% GDP²→−0.062%). Espoir et al. (2023) focus on 47 African countries (1996–2019) using panel cointegration and PMG-ARDL; they also confirm an EKC (1% GDP→+0.61% emissions, 1% GDP²→−0.03% emissions). They find that renewables curb emissions while stronger governance correlates with higher emissions, with bidirectional causality, and notably report no significant short-run growth effect on emissions. Acheampong and Opoku (2023) take a global view (140 countries, 1980–2021) with system-GMM, finding that environmental degradation overall retards growth. They still observe CO_2 forming an inverted-U with GDP while ecological footprint exhibits a U-shape, highlighting health, FDI, and innovation as channels. Robust as these analyses are, their divergence is glaring. Mohammed et al.'s (2024) EU results suggest advanced economies may "grow green," whereas Espoir et al.'s (2023) African sample shows growth still drives pollution, and Acheampong and Opoku's (2023) global model warns that unchecked degradation undermines development. Whilst these studies contribute valuable insights, their strengths coexist with limitations such as regional specificity, panel heterogeneity, endogeneity concerns that caution against broad generalisations.

Other studies provide findings against the EKC hypothesis. Aye and Edoja (2017) challenge the EKC hypothesis in developing countries. Analysing a 31-country panel with a dynamic threshold model, they show that growth lowers CO_2 in a low-growth regime but raises it in high-growth regimes. This yields a clear U-shaped (not inverted-U) pattern: no EKC. Energy use and population consistently drive-up emissions, while adding financial development to the model does not restore the EKC. Aye and Edoja's (2017) methodology is rigorous with thresholds capturing nonlinearity, but the choice of countries and regimes partly drives the finding. It suggests that in many developing contexts, continued growth still worsens pollution unless structural changes occur. Ehigiamusoe and Lean (2019) also find mixed results. Using cointegration methods on 122 countries, they report that energy use, income, and financial development usually increase CO_2 overall. However, when splitting by income group, high-income nations see growth and finance reduce emissions, whereas low- and middle-income groups experience the opposite. Hence, only rich countries reach the "turning point." This complex finding highlights that context matters—the EKC may hold only for advanced economies. A critique is that global panels can suffer from cross-country heterogeneity and omitted variables (technological change, regulations) that vary by country; the authors address this with advanced econometrics, but room for nuance remains.

Considering country-specific findings, Raihan et al. (2022) provide a country-level perspective on Bangladesh (as above in channel section). In addition to channel effects, they show that long-run growth in Bangladesh correlates with higher CO_2, while investment in renewables and (weakly) in innovation push emissions down. In plain terms, Bangladesh's economic expansion has so far increased its carbon footprint, highlighting the need for policy shifts. The study's detailed approach is a strength, but country-specific factors (like Bangladesh's energy mix and development strategy) mean one should not assume the same coefficients hold in other South

Asian or developing economies. Yue and Qiaoyu (2023) zoom in on China's Henan province (1994–2020) with a vector autoregression framework. They report that GDP growth Granger-causes increases in several pollutants (exhaust gases, SO_2, wastewater), and conversely some pollutants affect GDP. Their impulse-responses imply feedback loops: for instance, a 1% rise in industrial exhaust gas raises Henan's GDP per capita by about 0.22%, and a 1% rise in SO_2 raises it by 0.35%. Such findings suggest that, at least in the short run, pollution-intensive industry fuels growth. The study's strength is its detail on specific pollutants, but its limitation is scope; one province's experience (in the context of China's unique industrial policies) may not generalise elsewhere.

Mitić et al. (2023) examine eight South-Eastern European (SEE) countries (1995–2019) with panel cointegration and causality tests. They find short-run bidirectional causality between CO_2 and employment, and between energy availability and employment. That is, economic activity, jobs and emissions feed into each other in the short term. In the long run, their error-correction terms are significant, indicating that growth, energy and employment tend to return to equilibrium relationships. A variance decomposition shows how shocks dissipate over time. This study is technically sound for its region, but it fails to isolate an EKC shape; rather, it depicts an interlink of growth, employment and emissions. Its regional focus is useful for SEE policy, but generalisability is limited.

Overall, EKC evidence is mixed in extant literature—the EU shows inverted-U dynamics (Mohammed et al., 2024), African data confirm inverted-U trends (Espoir et al., 2023), and a global panel highlights inverted-U patterns with health, FDI, and innovation channels (Acheampong and Opoku, 2023). Yet developing-country analyses reveal U-shaped or absent EKC relationships (Ehigiamusoe & Lean, 2019; Aye and Edoja, 2017). Bangladesh and Henan cases illustrate localised emission–growth dynamics (Yue and Qiaoyu, 2023; Raihan et al., 2022), while SEE findings reveal growth–employment–emissions interlinkages (Mitić et al., 2023). This complexity underscores the need for context-specific policies in a resource-dependent economy like Nigeria.

Material and Methods

In this current study, the selected research design is the ex-post facto. The ex-post facto design is particularly suited for studies aiming to decipher statistical associations between dependent and independent variables, primarily to establish cause-and-effect relationships. It is a design that not only allows for the testing of hypotheses about the study's relationships but also effectively integrates theoretical review with empirical findings (Ekonomou and Halkos, 2023)

Model Specification

The model used in this current study is based on the EKC theoretical framework and an adapted modified version of the model of Abubakar and Abdullahi (2022), who examined how CO_2 emissions affected economic growth and whether or not that relationship depended on Nigeria's financial development between 1980 and 2020. Abubakar and Abdullahi (2022) model is of the form:

$$GDP = f(\alpha + \beta_1 EM + \beta_2 FD + \beta_3 EC + \mu) \tag{5}$$

Where, GDP represents economic growth; EM is CO_2 emissions; FD represents financial development; EC represents energy consumption; and μ is the error term.

In this current study, equation (5) is expanded and adjusted focusing on the potential linkages or pathways such as trade openness, FDI and health expenditure per capita through which environmental degradation affects economic growth. The modifications and extensions follows:

$$GDPPC_t = \beta_0 + \beta_1 C02_t + \beta_2 TOP_t + \beta_3 FDI_t + \beta_4 HEXPc_t + \mu_t \tag{6}$$

To guarantee consistency across the dependent and explanatory variables, we log-transformed the variables in equation (6) to:

$$InGDPPC_t = \beta_0 + \beta_1 InC02_t + \beta_2 InTOP_t + \beta_3 FDI_t + \beta_4 InHEXPc_t + \varepsilon_t \tag{7}$$

Where, In = Natural logarithm; GDPPC = GDP per capita to represents economic growth; CO_2 = CO_2 emissions (kt), which serves as the main indicator of environmental degradation in the literature (Opoku et al., 2022; Zheng et al., 2019; Pal and Mitra, 2017); TOP = represents trade openness; FDI = foreign direct investment; HEXPc = health expenditure per capita; β_0= intercept or autonomous parameter estimate; $\beta_1 \ldots \beta_4$ = Parameter estimate representing the coefficient of CO_2, TOP, FDI and HEXPc, respectively; and ε_t = other variables not explicitly included in the model. Furthermore, a positive coefficient for each variable is anticipated. However, it is anticipated that either a positive or a negative effect on economic growth will result from environmental degradation as measured by CO_2 emissions.

In analysing the impact of environmental degradation on economic growth in Nigeria, the Fully Modified Ordinary Least Squares (FMOLS) technique was employed. FMOLS uses a non-parametric method to account for endogeneity problems, corrects serial

correlation and simultaneous bias and gives robust results. It provides optimal estimates of cointegrating regressions and modifies least squares to account for serial correlation effects and for the endogeneity in the explanatory variables, when there is cointegration (Phillips, 1995). This framework thus helps in dealing with validity of inference, serial correlation effects and the problem associated with endogeneity. Building equations (7) into a FMOLS model, we have:

$$InGDPPC_t = \beta_0 + \sum_{t=1}^{T} \beta_1\, InC02_t{}^* + \sum_{t=1}^{T} \beta_2\, InTOP_t{}^* + \sum_{t=1}^{T} \beta_3\, FDI_t{}^* + \sum_{t=1}^{T} \beta_4 InH\,EXPc_t{}^* + \varepsilon_t \quad (8)$$

Where $GDPPC_t{}^*$, $C02_t{}^*$, $TOP_t{}^*$ $FDI_t{}^*$, and $HEXPc_t{}^*$ are the transformed variables adjusted for serial correlation and endogeneity. Equation (8) represents the long-run relationship between environmental degradation and economic growth in Nigeria using FMOLS. The coefficients $\beta_1 - \beta_4$ give insights into how each of the selected environmental degradation indicators impacts economic growth in Nigeria.

Additionally, the FMOLS offers flexibility in terms of the integration order of the variables under study. By implication, whether the variables are integrated or order zero, one, mixed or even fractionally integrated, the FMOLS can be effectively applied. This versatility allows for a rigorous analysis without imposing strict assumptions about the integration properties of time series data.

Variables Description and Measurements

The current study utilised set of macroeconomic indicators in analysing the interaction between growth and environmental degradation in the case of Nigeria. The choice of each of the variables was determined by its importance in the literature and its ability to capture the dynamics in focus. Table 1 gives the variables used in the study with their respective acronym, their description, the methodology of measurement and the source of data available.

Result and Discussion

Based on several econometric approaches used in examining the long-run link between economic growth and environmental degradation in Nigeria, this section offers the empirical results of the study. Descriptive

Table 1. Variables Description and Measurements.

Variable	Acronym	Description	Measurement	Source
Economic Growth	GDPPC	In this study, economic growth is measured using real GDP per capita (constant 2015 US$), which is the total value of goods and services produced by a country divided by its population.	Annual US$ Billion	World Development Indicators (World Bank, 2024)
Environmental Degradation	CO_2	The degradation of the environment is gauged by terrestrial CO_2 emissions, which come from burning fossil fuels as a result of both industrial processes and human activities.	Metric tons per capita	World Development Indicators (World Bank Group, 2024)
Trade Openness	TOP	Trade openness measured with trade (% of GDP) is reductions in trade barriers, liberalised external capital flows, diffusion of technology and international migration of labour	Annual (% of GDP)	World Development Indicators (World Bank Group, 2024)
Foreign direct investment	FDI	An investment made by a business or individual from one country into business ventures located in another. The measurement unit is Net Inflows (% of GDP).	Annual (Percentages)	World Development Indicators (World Bank Group, 2024)
Health Expenditure Per Capita	HEXPc	Health expenditure per capita is the amount of health expenditure per capita in US dollars	Annual US$ Billion	World Development Indicators (World Bank Group, 2024)
				Source: Researchers' Compilation, 2025

DOI: https://doi.org/10.52756/ijerr.2025.v47.015

statistics open the study; then, pre-estimation tests, including the Engle-Granger residual-based cointegration test and the Augmented Dickey-Fuller (ADF) unit root test, follow. To evaluate the long-term consequences of the chosen environmental degradation channels, lastly the Fully Modified Ordinary Least Squares (FMOLS) estimator is applied. EViews 12, a package routinely used in time series and panel data analysis due to its great capacity in handling stationarity tests, cointegration, and advanced estimators like FMOLS, helped all estimates be conducted.

Descriptive Statistics

Table 2. Summary of Descriptive Statistics.

	GDPPC	CO_2	TOP	FDI	HEXPC
Mean	1632.619	87380.81	0.454027	1.297644	57.41362
Median	1818.418	93617.05	0.427157	1.288550	65.71326
Maximum	3200.953	119544.1	0.687665	2.900249	106.1196
Minimum	494.1292	0.537510	0.263519	-0.039520	17.65199
Std. Dev.	800.1632	29909.74	0.112007	0.840659	28.15563
Skewness	-0.014097	-2.145311	0.346049	0.168133	-0.128650
Kurtosis	1.888923	6.962445	1.923108	1.897291	1.765094
Jarque-Bera	1.749991	48.32308	2.321486	1.882810	2.254194
Probability	0.416864	0.000000	0.313253	0.390079	0.323972
Observations	34	34	34	34	34

Source: Researcher's Computations, 2025

As a way of understanding the distribution and nature of data used in conducting the study, descriptive statistics in Table 2 were computed on each of the variables.

From Table 2, GDP Per Capita (GDPPC) has an approximate average of $1632.619 billion and it ranges from 494.1292 (minimum) to 3200.953 (maximum), with a standard deviation of $800.1632 billion. Similarly, CO_2 has a mean value of 87380.81kt, standard deviation of 29909.74 kt, with minimum and maximum of 0.537510 and 119544.1, respectively. While TOP has a mean value of 0.45%, with a standard deviation of 0.11%, minimum and maximum values of 0.263519 and 0.687665, respectively. Comparably, FDI has an approximate average of 1.29% and it ranges from -0.039520 (minimum) to 2.900249 (maximum), with a standard deviation of 0.84%. While, Health Expenditure Per Capita has an approximate average of $17.65199 billion and it ranges from 17.65199 (minimum) to 106.1196 (maximum), with a standard deviation of $28.15563 billion.

Table 2 displays the skewness coefficient, a measure of how far a distribution deviates from symmetry. All of the data variables have skewness values less than one, with the exception of CO_2 with coefficient that is greater than one (-2.145311). The entire data series is not platykurtic (not having negative values), as confirmed by the kurtosis result, which measures a distribution's degree of peaked-ness in relation to a normal distribution. Additionally, the probability value of Jarque-Bera statistics indicated that majority of the variables are normally distributed with p-values greater than 5%. To ensure that the collected data fit the study, a stationarity test was conducted on the data.

Pre-Estimation Test Results

Unit Root Results

A unit root test, such as the Augmented Dickey-Fuller (ADF) test, is a common statistical method used to determine whether a time series data set is stationary. Stationarity implies that the statistical properties of the series such as mean, variance, and autocorrelation are constant over time. Non-stationary data, on the other hand, can have properties that change over time, which can lead to spurious results in regression analysis. A series with a unit root is non-stationary but can be made stationary through differencing, hence the term 'order of integration' (Akinbola, 2021). The ADF test checks for a unit root in a time series by testing the null hypothesis that the series has a unit root (non-stationary) against the alternative hypothesis that the series is stationary. The ADF unit root test results are displayed in Table 3 as follows:

All five variables (GDPPC, CO_2, TOP, FDI, and HEXPC) are integrated of order one, or I(1), according to the results of the stationarity test in Table 4.3, indicating that each of them becomes stable after taking its first differences. By implications, the stationarity at the first difference allows for their use in econometric models that require stationary data, such as cointegration and FMOLS model, to analyse the long-term relationship between economic growth and channels of environmental degradation.

DOI: https://doi.org/10.52756/ijerr.2025.v47.015

Table 3. Traditional Unit Root Test Results (Trend and Intercept).

Variable	Method	Level	First Diff.	Order of Integration
		Stat. (Prob.)	Stat. (Prob.)	
GDPPC	ADF	-1.478684 (0.8167)	-4.590412*(0.0046)	I(1)
CO_2	ADF	-1.058847 (0.7200)	-5.283277*(0.0001)	I(1)
TOP	ADF	-2.791255 (0.0704)	-6.775533*(0.0000)	I(1)
FDI	ADF	-2.426703 (0.1425)	-6.973697*(0.0000)	I(1)
HEXPC	ADF	-2.306416 (0.4184)	-5.135602*(0.0012)	I(1)

Note: * Indicates stationary at the 1% level; **Source:** Researcher's Computations, 2025

Table 4. Result of Engle and Granger (Residual-Based) Cointegration Test.

Residual		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic @ (Levels)		-3.367757*	0.0013
Test critical values:	1% level	-2.678359	
	5% level	-1.756406	
	10% level	-1.818495	

Note: * significant at 1%; **Source:** Researcher's Computations, 2025

Table 5. FMOLS Result.
Dependent Variable: LOG(GDPPC)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CO_2)	0.027704	0.014487	1.912307	0.0661
LOG(TOP)	0.062657	0.194340	0.322409	0.7495
FDI	-0.173896	0.053225	-3.267163	0.0029
LOG(HEXPC)	0.875654	0.074856	11.69779	0.0000
C	3.853384	0.442093	8.716224	0.0000
R-squared	0.816342			
Adjusted R-squared	0.790105			
Wald-Fstat	40.48825			
Wald-pvalue	0.0000			
Long-run variance	0.059360			

Source: Researcher's Computations, 2025

Co-integration Results

Co-integration makes sure that even non-stationary individual series can have stationary linear combinations, indicating a constant long-term association between them. To determine whether the relevant variables have a long-term relationship, the Engle and Granger (Residual Based) Cointegration Test was employed. Table 4 summarises the findings of the Co-integration test utilising the Engle and Granger (Residual Based) Cointegration Test.

The results of Engle and Granger Residual Based Cointegration Test is -3.367757, exceeding the critical value at the 1% significance level of -2.678359, suggesting co-integration. This indicated that the null hypothesis of no cointegration is rejected at the 1% level, meaning that a significant long term equilibrium relationship exists amongst the variables under review. The estimation of FMOLS regression was then carried out.

FMOLS Regression Results

FMOLS regression findings for the model are shown in Table 5 to provide some intriguing insights into the direct influences of environmental degradation channels on economic growth in Nigeria from 1990-2023.

From Table 5, two out of the four explanatory variables used in this study have statistically significant influence on economic growth in the long run. Furthermore, CO_2 emissions, a measure of environmental degradation, trade openness health expenditure per capita are in agreement with this study apriori expectations. However, FDI does not conform to this study apriori expectations in the long run. Additionally, the positive relationship between CO_2 emissions, a measure of environmental degradation and economic growth does not align with earlier research. For example, Aye and Edoja (2017) and Raihan et al. (2022) found a significant inverse relationship between carbon emissions and

DOI: https://doi.org/10.52756/ijerr.2025.v47.015

economic growth in Nigeria and Bangladesh, respectively.

Discussion

The estimated FMOLS regression results indicated that two channels or pathways, such as FDI and health expenditure per capita, through which environmental degradation affects economic growth, have a statistically significant influence on GDP per capita (GDPPC), a proxy for economic growth in the long run. Furthermore, CO_2 emissions, a measure of environmental degradation, trade openness, and health expenditure per capita are in agreement with this current study's a priori expectations. Specifically, the positive relationship between CO_2 emissions and economic growth suggests that as the level of carbon emissions increases, economic growth increases by approximately 0.028% ceteris paribus in the long run.

The above finding of a positive relationship between CO_2 emissions and economic growth, as reported in Table 5, is in conformity with theoretical predications that during early stages, growth is associated with increasing emissions. However, as economies of scale, income, and innovation increase, higher output becomes environmentally sustainable. Accordingly, an inverted U-shaped association between environmental degradation and economic growth was established by this current study. This finding has been widely accepted as Kuznets inverted U-shaped curve. By implication, more economic activity would accelerate the destruction of Nigeria's environment. These findings add to a growing body of research on the growth–environment nexus (Ehigiamusoe et al., 2022; Espoir et al., 2023; Lin et al., 2021; Munir et al., 2020; Mohammed et al., 2024; Zhang et al., 2021).

From Table 5, the R-squared value of 0.816342 implies that the model is a good fit, as over 82% of the variation in economic growth is explained by the explanatory variables. Even after removing the impact of insignificant estimators, the adjusted R-squared value of 0.790105 implies that the model is still very good. Therefore, this study's conclusion can be relied upon for formulating policy recommendations. The Wald F-statistic of 40.48825, along with a Wald p-value of 0.0000 highlighted the overall reliability and significance of the model. By implications, the selected environmental degradation variables have statistically significant influence on economic growth, hence reinforcing the validity of the model. While the long-run variance of 0.059360 provided an estimate of the variability of the residuals over the long term. A relatively low long-term variance indicated that the residuals (or errors) in the model are stable over time, suggesting that the model is reliable for predicting the long-term relationship between selected environmental degradation channels and economic growth.

Conclusion and Recommendations

This current study, conducted with a sense of urgency, investigated the impact of environmental degradation on economic growth in Nigeria between 1990 and 2023. The study focused on transmission channels such as trade openness, FDI, and health expenditure per capita. It contributes to the ongoing debate on the existence and policy relevance of the Environmental Kuznets Curve hypothesis in the Nigerian context. The FMOLS approach procedure was adopted to capture long-run association among variables. The estimated FMOLS regression revealed that two out of the four explanatory variables used in this study significantly influence economic growth in the long run. This study established an inverted U-shaped association between environmental degradation and economic growth since CO_2 emissions and economic growth are positively related. Therefore, the following recommendations were obtained from the research findings:

To mitigate carbon emissions, the National Environmental Standards Regulatory and Enforcement Agency should strengthen environmental regulations and encourage the adoption of green technologies to minimise the adverse impact of environmental degradation on economic growth, as reported in this study. The successful implementation of these policies could significantly reduce CO_2 emissions and create a healthier environment for future generations. Thus, policies targeting the reduction of CO_2 emissions should be implemented.

The Nigerian Export Promotion Council should design policies aimed at improving trade efficiency, market diversification, and integration into global value chains, which can drive economic growth over time. The long-term positive relationship between trade openness and economic growth is a key reason for this.

Federal Ministry of Environment, in collaboration with the Nigerian Export Promotion Council, needs to revise its FDI policies to ensure that investments do not come at the expense of environmental sustainability. Efforts to attract 'green' FDI, which promotes sustainable industrial practices in the form of renewable energy projects or waste management initiatives, should be emphasised. Such investments can ensure Nigeria's economic growth is not at the cost of environmental degradation.

The Federal Ministry of Health should prioritise increasing per capita health investments. This will enhance the country's overall health outcomes and contribute to its long-term economic growth. Since environmental degradation is linked to poor health, integrated health-environment policies that focus on mitigating pollution while improving public health infrastructure should also be developed. For example, increased healthcare funding can be paired with reduced air and water pollution measures.

Acknowledgement

The authors would like to thank the World Bank Group and the authors of the cited studies for their open access to the data utilised in this study. Their dedication to data transparency significantly helped accomplish this research.

Conflict of Interest

The authors declare no conflict of interest.

References

Abdulkarim, Y. (2023). Dynamic effects of energy consumption, economic growth, international trade and urbanization on environmental degradation in Nigeria. *Energy Strategy Reviews*, *50*, 1-12. https://doi.org/10.1016/j.esr.2023.101228

Abubakar, H., & Abdullahi, K. T. (2022). Carbon dioxide emissions and economic growth nexus in Nigeria: The role of financial development. *American Journal of Social Sciences and Humanities*, *7*(2), 69–84. https://doi.org/10.55284/ajssh.v7i2.736

Acheampong, A. O., & Opoku, E. E. O. (2023). Environmental degradation and economic growth: Investigating linkages and potential pathways. *Energy Economics*,123. https://doi.org/10.1016/j.eneco.2023.106734

Adu, D. T., & Denkyirah, E. K. (2018). Economic growth and environmental pollution in West Africa: Testing the Environmental Kuznets Curve hypothesis. *Kasetsart Journal of Social Sciences*, *40*, 281–288. https://doi.org/10.1016/j.kjss.2017.12.008

Agbana, J., Abubakar, A., Abdullahi, M. B., Oladipo, O., & Arinze-Emefo, I. (2024). Economic growth in emerging markets: The influence of foreign direct investment on renewable energy. *Open Journal of Business and Management*, *12*(04), 2683–2708. https://doi.org/10.4236/ojbm.2024.124139

Akinbola, A. E. (2021). Co-integration and error correction modeling of agricultural output: The case of cassava in Ondo state, Nigeria. *International Journal of Advanced Economics*, *3*(3), 72–79. https://doi.org/10.51594/ijae.v3i3.238

Aluko, O. A., Opoku, E. E. O., & Ibrahim, M. (2021). Investigating the environmental effect of globalization: Insights from selected industrialized countries. *Journal of Environmental Management*, *281*, 111892. https://doi.org/10.1016/j.jenvman.2020.111892

Amar, A. B. (2021). Economic growth and environment in the United Kingdom: robust evidence using more than 250 years data. *Environmental Economics and Policy Studies*, *23*(4), 667–681. https://doi.org/10.1007/s10018-020-00300-8

Awosusi, A. A., Xulu, N. G., Ahmadi, M., Rjoub, H., Altuntaş, M., Uhunamure, S. E., Akadiri, S. S., & Kirikkaleli, D. (2022). The Sustainable Environment in Uruguay: the roles of financial development, natural resources, and trade globalization. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.875577

Aye, G. C; & Edoja, P. E. (2017). Effect of economic growth on CO_2 emission in developing countries: Evidence from a dynamic panel threshold model. *Cogent Economics & Finance*, *5*, 1-22. https://doi.org/10.1080/23322039.2017.1379239

Cetin, M. A. (2018). Investigating the environmental Kuznets curve and the role of green energy: Emerging and developed markets. *International Journal of Green Energy*, *15*(1), 37–44. https://doi.org/ 10.1080/15435075.2017.1413375

CountryEconomy. (2023). *Nigeria CO_2 emission 2023*. Retrieved from https://countryeconomy.com/energy-and-environment/co2-emissions/nigeria

Ehigiamusoe, K. U., & Lean, H. H. (2019). Effects of energy consumption, economic growth, and financial development on carbon emissions: evidence from heterogeneous income groups. *Environmental Science and Pollution Research*, *26*(22), 22611–22624. https://doi.org/10.1007/s11356-019-05309-5

Ekonomou, G., & Halkos, G. (2023). Exploring the Impact of Economic growth on the environment: An overview of trends and developments. *Energies*, *16*(11), 4497. https://doi.org/10.3390/en16114497

Espoir, D. K; Sunge, R., & Bannor, K. (2023). Exploring the dynamic effect of economic growth on carbon dioxide emissions in Africa: evidence from panel

PMG estimator. *Environmental Science and Pollution Research, 30*, 112959–112976. https://doi.org/10.1007/s11356-023-30108-4

Grossman, G. M; & Krueger, A. B. (1995). Economic growth and the environment. *Quarterly Journal of Economics, 110*(2), 353–377. https://doi.org/ 10.2307/2118443

Hammed, O. M., Waliu, O. S., & Fatai, O. O. (2020). The relationship between environmental degradation, energy use and economic growth in Nigeria: New evidence from non-linear ARDL. *International Journal of Energy Sector Management*. https://doi.org/10.1108/IJESM-04-2019-0016.

IMF. (2023). *World Economic Outlook: Growth projections*. International Monetary Fund. Retrieved from https://www.imf.org/en/Publications/WEO/Issues/2023/04/11/world-economic-outlook-april-2023

Islam, M. S., & Beloucif, A. (2023). Determinants of Foreign Direct Investment: A Systematic Review of the Empirical Studies. *Foreign Trade Review*, *59*(2), 309–337. https://doi.org/10.1177/00157325231158846

Jayadevan, C. M. (2021). Impacts of health on economic growth: evidence from structural equation modelling. *Asia-Pacific Journal of Regional Science*, *5*(2), 513–522. https://doi.org/10.1007/s41685-020-00182-4

Kanat, O., Yan, Z., Asghar, M. M., Ahmed, Z., Mahmood, H., Kirikkaleli, D., & Murshed, M. (2022). Do natural gas, oil, and coal consumption ameliorate environmental quality? Empirical evidence from Russia. *Environmental Science and Pollution Research, 29*(3), 4540–4556. https://doi.org/10.1007/s11356-021-15989-7

Le, H. T. P., Pham, H., Thu, N. T., DO, & Duong, K. D. (2024). Foreign direct investment, total factor productivity, and economic growth: evidence in middle-income countries. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-03462-y

Lin, X., Zhao, Y., Ahmad, M., Ahmed, Z., Rjoub, H., & Adebayo, T. S. (2021). Linking innovative human capital, economic growth, and CO_2 emissions: An empirical study based on Chinese provincial panel data. *International Journal of Environmental Research and Public Health*, *18*(16), 1– 18. https://doi.org/10.3390/ijerph18168503

Macrotrends. (2023). *Nigeria GDP per capita*. Retrieved from https://www.macrotrends.net/countries/NGA/nigeria/gdp-per-capita

Maneejuk, N., Ratchakom, S., Maneejuk, P., & Yamaka, W. (2020). Does the environmental Kuznets curve exist? an international study. *Sustainability*, *12*(21), 9117. https://doi.org/10.3390/su12219117

Mitić, P; Fedajev, A; Radulescu, M; & Rehman, A. (2022). The relationship between CO_2 emissions, economic growth, available energy, and employment in SEE countries. *Environmental Science and Pollution Research*, *30*, 16140–16155. https://doi.org/10.1007/s11356-022-23356-3.

Mitkova, Z., Doneva, M., Gerasimov, N., Tachkov, K., Dimitrova, M., Kamusheva, M., & Petrova, G. (2022). Analysis of healthcare expenditures in Bulgaria. *Healthcare*, *10*(2), 274. https://doi.org/10.3390/healthcare10020274

Mohammed, S., Gill, A. R.., Ghosal, K., Al-Dalahmeh, M., Alsafadi, K., Szabo, S., Olah, J., Alkerdi, A. O. & Harsanyi, E. (2024). Assessment of the Environmental Kuznets Curve within EU-27: Steps toward environmental sustainability. *Environmental Science and Ecotechnology*, 18. https://doi.org/10.1016/j.ese.2023.100312

Mugun, N. W. (2021). Effect of trade openness on economic growth in Sub-Saharan Africa: dynamic panel analysis. *EPRA International Journal of Economics Business and Management Studies*, 23–35. https://doi.org/10.36713/epra6388

Munir, Q., Lean, H. H., & Smyth, R. (2020). CO_2 emissions, energy consumption and economic growth in the ASEAN-5 countries: A crosssectional dependence approach. *Energy Economics*, *85*, 1–10. https:// doi.org/10.1016/j.eneco.2019.104571.

Nguyen, H. A., Ahmed, S., & Turner, H. C. (2023). Overview of the main methods used for estimating catastrophic health expenditure. *Cost Effectiveness and Resource Allocation*, *21*(1). https://doi.org/10.1186/s12962-023-00457-5

Ogunbode, T., Omotayo, O., Asifat, J., Ogunbile, P., Olatubi, I., & Oyebamiji, V. (2021). Challenges of degradation in the Tropical Environment: Causes, Footprints and Remedies. *Aswan University Journal of Environmental Studies*, https://doi.org/10.21608/aujes.2021.89948.1035

Opoku, E. E. O., Acheampong, A. O., Dzator, J., Kufuor, N. K. (2022). Does environmental sustainability attract foreign investment? Evidence from developing countries. In: Business Strategy and the Environment. https://doi.org/10.1002/bse.3104.

Orji, A., Ogbuabor, J. E., Aza, G. C., & Anthony-Orji, O. I. (2021). Does Foreign Presence Influence the Level of Firm Technical Efficiency? Evidence from Africa. *Econometric Research in Finance*, *6*(1), 1–20. https://doi.org/10.2478/erfin-2021-0001

Pal, D., & Mitra, S. K. (2017). The environmental Kuznets curve for carbon dioxide in India and China: Growth and pollution at crossroad. *Journal of Policy Modeling*, *39*(2), 371–385. https://doi.org/10.1016/j.jpolmod.2017.03.005

Phillips, P. C. B. (1995). Fully modified least squares and vector autoregression. *Econometrica, 63*(5), 1023–1078. https://doi.org/10.2307/2171721

Pona, H. T., Xiaoli, D., Ayantobo, O. O., & Tetteh, N. N. D. (2021). Environmental health situation in Nigeria: current status and future needs. *Heliyon*, *7*(3), e06330. https://doi.org/10.1016/j.heliyon.2021.e06330

Raihan, A., Muhtasim, D. A., Khan, M. N. A., Pavel, M. I., & Islam, M. T. (2022). Nexus between carbon emissions, economic growth, renewable energy use, and technological innovation towards achieving environmental sustainability in Bangladesh. *Cleaner Energy Systems*, *3*, 100032. https://doi.org/10.1016/j.cles.2022.100032

Rehman, M. A. U., Shaheen, R., & Munir, F. (2021). Impact of trade openness on economic growth in emerging Economies: a panel data analysis. *Pakistan Journal of Humanities and Social Sciences*, *9*(2), 210–216. https://doi.org/10.52131/pjhss.2021.0902.01127

Saba, C. S. (2022). CO_2 emissions-energy consumption-militarisation-growth nexus in South Africa: evidence from novel dynamic ARDL simulations. *Environmental Science and Pollution Research*, *30*(7), 18123–18155. https://doi.org/10.1007/s11356-022-23069-7

Beyene, S. D., & Kotosz, B. (2019). Testing the Environmental Kuznets Curve hypothesis: an empirical study for East African countries. *International Journal of Environmental Studies*, *77*(4), 636–654. https://doi.org/10.1080/00207233.2019.1695445

Stern, D. I. (2004). The rise and fall of the Environmental Kuznets Curve. *World Development, 32*(8), 1419–1439. https://doi.org/10.1016/j.worlddev.2004.03.004

World Bank Group. (2024). *World Bank Open Data of Nigeria*. World Bank Open Data. Retrieved January 31, 2025, from https://data.worldbank.org/country/nigeria

Yan, C., Li, H., & Li, Z. (2022). Environmental pollution and economic growth: Evidence of SO_2 emissions and GDP in China. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.930780

Yue, Z., & Qiaoyu, S. (2023). Research on the Relationship between Industrial Pollution and Economic Development in Henan Province Based on EKC Theory. *Population Resources & Environmental Economics*, *4*(1). https://doi.org/10.23977/pree.2023.040110

Zhang, L., Godil, D. I., Bibi, M., Khan, M. K., Sarwat, S., & Anser, M. K. (2021). Caring for the environment: How human capital, natural resources, and economic growth interact with environmental degradation in Pakistan? A dynamic ARDL approach. *Science of the Total Environment*, *774*, 1–12. https://doi.org/10.1016/j.scitotenv.2021.145553

Zhang, M., Chen, Y., Lyulyov, O., & Pimonenko, T. (2023). Interactions between economic growth and environmental degradation toward sustainable development. *Systems*, *11*(1), 13. https://doi.org/10.3390/systems11010013.

How to cite this Article:

Jonathan Ojarikre Oniore and Pureheart Ogheneogaga Irikefe (2025). Environmental Degradation Channels and Economic Growth in Nigeria: 1990-2023. *International Journal of Experimental Research and Review, 47*, 174-185.

DOI : https://doi.org/10.52756/ijerr.2025.v47.015